

Being There: Capturing and Experiencing a Sense of Place

Richard Szeliski
Microsoft Research
Symposium on Computational
Photography and Video

Early art: events



Lascaux

Early art: events



Early art: events



BAYEUX TAPESTRY

Bayeux Tapestries

Renaissance art: events



Da Vinci

Baroque art: portraits



Rembrandt

Baroque art: landscapes



Rembrandt

Classical art: landscapes



Corot

Impressionism: landscapes



Monet

Modern art: multi-perspective



Picasso

Impressionism: landscapes



Monet

Photography: events



Henri Cartier-Bresson

Photography: landscapes



Ansel Adams

Photography: landscapes



Galen Rowell

Photography: landscapes



Art Wolfe

Interactive Visual Media

- ~~Branching~~ **Branching** storytelling
 - problem solving, skill acquisition



- sense of place, navigation

Real-world “immersive” media

- Recapturing the sense of place
- QTVR: the first real breakthrough in modeling from *reality*?



- Fairly universal for high-end home and car sales, virtual tourism
- Limitations: mostly static, discrete jumps

Increasing realism

- Better:
 - field of view and resolution
 - Demo:** Space Needle
 - dynamic range
- Additional cues/modalities:
 - motion / movement
 - Demo:** Deception Falls
 - sound

VR Tools

Fully automated stitch discovery

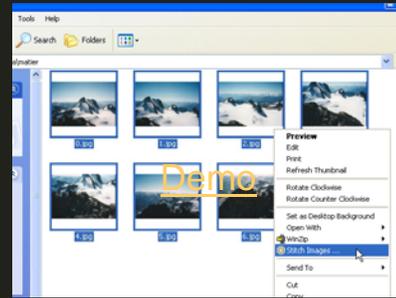


Image stitching — open issues

- Fully automated assembly (no ordering)
- Full 2D stitching (multiple rows)
- Double image fix-up (*de-ghosting*)
- Merging different exposures
- Automated grouping/clustering (detection)



HDR: merging exposures



Inputs



Tonemapped output:
no motion compensation
or consistency check

HDR: merging exposures



Inputs



Tonemapped output:
global+local motion
compensation

Video Textures

- How can we turn a short *video clip* into continuous video?

– Enhance sense of *liveness*



– Use in games and presentations

Video Textures

1. Find cyclic structure in the video



2. Play frames with random shuffle
3. Optional region-based analysis
4. Smooth over discontinuities (morph)

Animating Stills

- What if we only have a *single* beautiful photo (or painting)?



- Can we add so *liveness* to a photo/still?

Animating Pictures with Stochastic Motion Textures

Increasing “immersion”

- Add *continuous* movement



Demo
Bellevue Botanical Garden

Demo
HDR Home Walkthrough

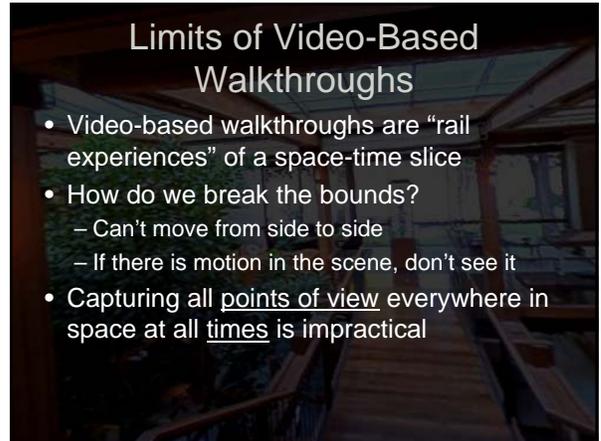
Video-based walkthroughs

- Add *continuous* movement
- How did we do this?
- Is this 3D? 2D?
Graphics? Video?
- Dimensionality and storage?



Limits of Video-Based Walkthroughs

- Video-based walkthroughs are “rail experiences” of a space-time slice
- How do we break the bounds?
 - Can't move from side to side
 - If there is motion in the scene, don't see it
- Capturing all points of view everywhere in space at all times is impractical



A Practical 3D Video Camera

- Working volume?
 - Walls of a room: Virtualized Reality
 - 2D “window”: LightField Array
 - 1D “rail”: Virtual Viewpoint Video



“3D” video

Massive Arabesque

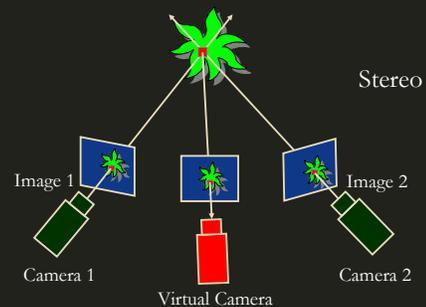


Virtual Viewpoint Video

Capture multiple synchronized video streams

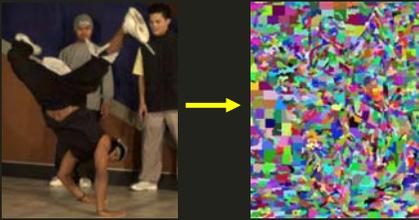


Key to view interpolation: Geometry

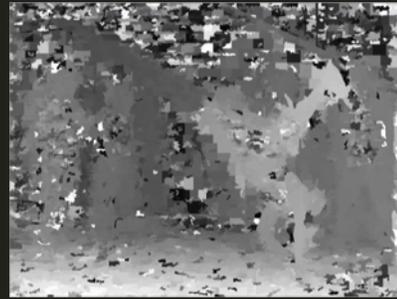


Don't match pixels – match segments

- Segments contain more information, so they're easier to match.



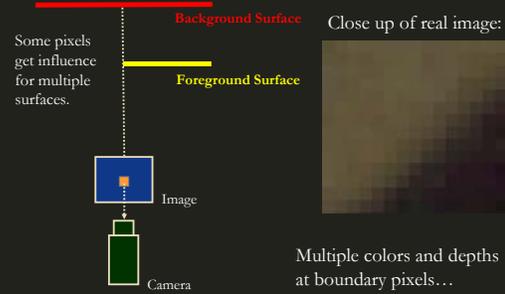
Iteratively update depths



Depth through time:



Matting

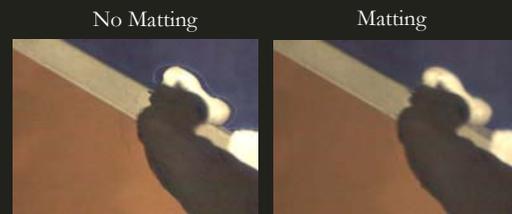


Find matting information:

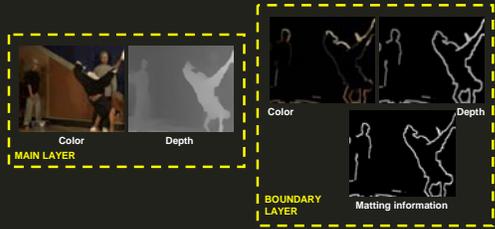
1. Find boundary strips using depth.
2. Within boundary strips compute the colors and depths of the foreground and background object.



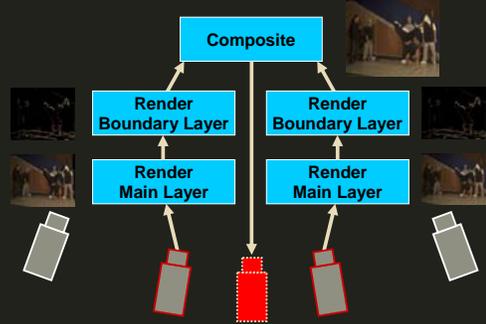
Why matting is important



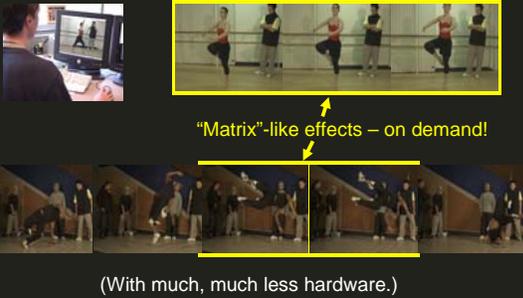
Representation



Rendering pipeline (GPU)



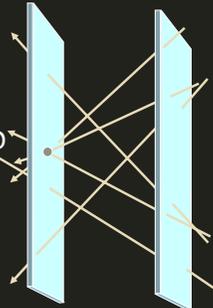
Real-time viewpoint control



Wrapping up...

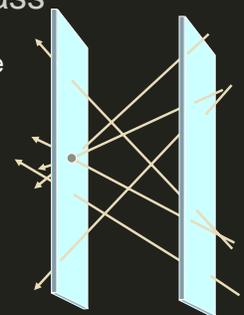
Light Field Rendering

- Sample and synthesize (capture and render) from a 4D ray space [Lightfield, Levoy & Hanrahan; Lumigraph, Gortler et al., SIGGRAPH'96]



Slow Glass

- What if we could capture all the photons and play them all back at a later time?



Light of Other Days
Bob Shaw, © 1969

http://www.scifi.com/scifiction/classics/classics_archive/shaw/shaw1.htm

Slow Glass

One could stand the glass beside, say, a woodland lake until the scene emerged, perhaps a year later. If the glass was then removed and installed in a dismal city flat, the flat would—for that year—appear to overlook the woodland lake. During the year it wouldn't be merely a very realistic but still picture—the water would ripple in sunlight, silent animals would come to drink, birds would cross the sky, night would follow day, season would follow season.

Apart from its stupendous novelty value, the commercial success of slow glass was founded on the fact that having a scenedow was the exact emotional equivalent of owning land. The meanest cave dweller could look out on misty parks—and who was to say they weren't his? A man who really owns tailored gardens and estates doesn't spend his time proving his ownership by crawling on his ground, feeling, smelling, tasting it. All he receives from the land are light patterns...

Being There

- Artists (and all of us) have always wanted to capture a sense of *being there*.
- Computational photography and video bring us a lot closer:
 - realism (field of view, resolution, contrast)
 - movement and sound
 - immersion and exploration
- What does the future hold?